2020 HSC Engineering Studies Marking Guidelines

Section I

Multiple-choice Answer Key

Question	Answer
1	A
2	C
3	D
4	A
5	B
6	D
7	C
8	C
9	A
10	A
11	B
12	B
13	D
14	A
15	A
16	C
17	B
18	D
19	C
20	B

Section II

Question 21 (a)

Criteria	Marks
• Outlines how one telecommunications engineering innovation has influenced traditional voice communication systems	2
• Provides some relevant information	1

Sample answer:

Telecommunications engineering innovation has supported the merging of IT and voice communication systems. Smartphones have potentially replaced landlines, support video conferencing, internet access and the way information is researched.

Answers could include:

- Cloud storage
- Cybersecurity
- The use of PBX (private branch exchange)
- Voice over IP (VoIP).

Question 21 (b)

Criteria	Marks
• Determines the correct outputs for *Z*, supported by a correct truth table	3
• Provides a mostly correct truth table	2
• Provides some relevant information	1

Sample answer:

A	*B*	*C*	*D*	*Z*
1	0	0	1	0
1	0	1	1	0
1	1	0	1	0
1	1	1	1	0

(There are no inputs at *B* or *C* that will produce a high (1) output at *Z*)

Note:

In the logic circuit diagram given in the question, the NOR gate was intended to be a NAND gate, to give the following answer:

A	*B*	*C*	*D*	*Z*
1	0	0	1	1
1	0	1	1	1
1	1	0	1	0
1	1	1	1	0

A high output at Z occurs when input B = 0 while input C = 0 or 1.

However, the NOR gate meant that there were no inputs at B or C that would produce a high (1) output at Z.

Students were able to access full marks by giving the first truth table above or by showing that a high (1) output at Z could be produced by varying the input at A and/or D.

Question 21 (c)

Criteria	Marks
• Demonstrates well-developed knowledge of AS 1100, using correct terminology	4
• Demonstrates sound knowledge of AS 1100, using mostly correct terminology	3
• Demonstrates some knowledge of AS 1100, using some correct terminology	2
• Provides some relevant information	1

Sample answer:

Drawing title is Encabulator part	*AS 1100 indicates* Australian Drawing Standard
Angle of projection is 3rd angle projection	*2:1 indicates* Scale
Feature 10 indicates Hidden detail	*Feature 5 indicates* Section (or cutting) plane
Correct name of View 2 is Section AA	*Feature 7 indicates* Counterbore
Detail missing in View 2 is Centreline	*Feature 6 indicates* Section Cross-hatching
Correct name of View 3 is Auxiliary View	*Fillet curve is indicated as* Feature 8
Detail missing in View 3 is Centreline	*Feature 4 indicates* Threaded hole

Question 21 (d)

Criteria	Marks
• Provides a correct explanation for the importance of each property	3
• Provides some correct explanations	2
• Provides some relevant information	1

Sample answer:

Property of ETP copper	*Explanation*
Electrical conductivity	The electrical conductivity of ETP copper is important in telecommunications because *it has low resistance and increases the efficiency of data transfer and electricity transmission*
Ductility	The ductility of ETP copper is important in telecommunications because *it allows the copper to be drawn into very fine wire which can then be made into very flexible cables.*
Corrosion resistance	The corrosion resistance of ETP copper is important in telecommunications because *it minimises the potential for utility downtime of a system due to the breakdown of the cable.*

Question 22 (a)

Criteria	Marks
• Outlines how an aeronautical engineering innovation has contributed to improved performance of modern aircraft	2
• Provides some relevant information	1

Sample answer:

Retrofitting of the winglets can reduce drag and turbulence, which in turn reduces fuel consumption. This means that aircraft can fly longer distances on the same amount of fuel.

Answers could include:

- Using turbofan engines rather than turbojet engines
- Using turbofan engines with a much higher bypass ratio.

Question 22 (b)

Criteria	Marks
• Describes the use of different types of materials for the wings over the last 100 years	3
• Outlines the use of different types of materials for the wings	2
• Provides some relevant information	1

Sample answer:

Originally the skin of the wing was made from (doped) fabric. Later, sheet metal alloys, including steel, aluminium and titanium replaced the fabric. These provided strength to the structure of the skin that the fabric was not able to provide. More recently, composite materials such as bi-metal alloys including fibre reinforced metal laminates have been used. These provide good strength to weight ratio.

Answers could include:

The use of materials for the frame of wings.

Question 22 (c)

Criteria	Marks
• Demonstrates a comprehensive understanding of an appropriate test for checking the airworthiness of the landing gear	4
• Demonstrates a sound understanding of an appropriate test for checking the airworthiness of the landing gear	3
• Demonstrates some understanding of an appropriate test for checking the airworthiness of the landing gear	2
• Provides some relevant information	1

Sample answer:

Ultrasonic testing can be used to determine whether fatigue/sub-surface cracking has developed within the landing gear. This test is appropriate because an Ultrasonic Testing Device is portable and can be used in situ and it will not damage any components as it is a non-destructive test.

Answers could include:

Dye penetrants (fluorescent dye penetrant), magnetic particles testing, radiography, visual/optical inspection and sonic resonance used for the determination of separation in laminates.

Question 22 (d)

Criteria	Marks
• Shows relevant working in the correct calculation of the force	4
• Makes progress towards calculating force using a substantially correct method	2–3
• Provides some relevant information	1

Sample answer:

Given :

$P_{ga} = 750\,\text{kPa}$

$P_{atm} = 100\,\text{kPa}$

$D = 15\,\text{mm}$

Find: F

$$P = P_0 + \rho gh$$

$$P_{abs} = P_{atm} + P_{ga}$$

$$P_{abs} = 750 + 100$$

$$P_{abs} = 850\,\text{kPa}$$

$$P_{abs} = \frac{F}{A}$$

$$F = P_{abs} \times A$$

$$A = \frac{\pi D^2}{4}$$

$$A = \frac{\pi \times 0.015^2}{4}$$

$$A = 1.77 \times 10^{-4}\ \text{m}^2$$

$$F = 850 \times 10^3 \times 1.77 \times 10^{-4}$$

$$F = 150.45\,\text{N}$$

Question 23 (a)

Criteria	Marks
• Compares TWO technologies used in modern bicycle frames to those used in earlier times	3
• Compares a technology used in modern bicycle frames to one used in earlier times	2
• Provides some relevant information about bicycle frames	1

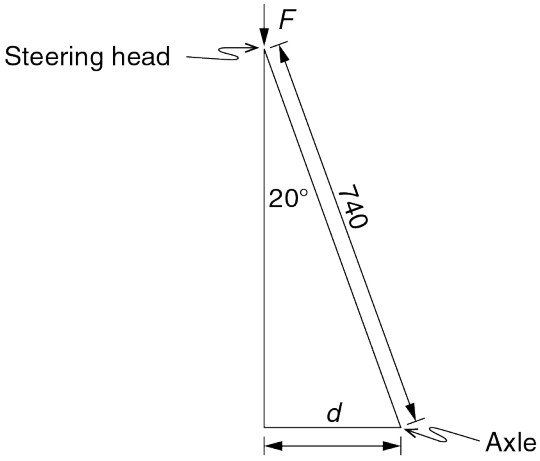
Sample answer:

One technology used in modern bicycle frames is ultra lightweight composite frames which have replaced the early heavy steel tubing frames. Another is seamless tubing now used for the modern cycles replacing the original tubing constructed from flat plate rolled and shaped around a mandrel to form a tube and then welded.

Question 23 (b) (i)

Criteria	Marks
• Shows relevant working in the correct calculation of the vertical force	3
• Makes progress towards calculating vertical force using a substantially correct method	2
• Provides some relevant information	1

Sample answer:



$\theta = 20°$

$h = 740$ mm

For d:

$$\sin 20° = \frac{d}{740}$$

$$d = 740 \sin 20°$$

$$d = 740 \times 0.342$$

$$\therefore \quad d = 253.09 \text{ mm}$$

$$M = F \times d$$

$$F = \frac{132.19}{0.25309}$$

$$\text{Force} = 522.5 \text{ N}$$

$55\% \times$ total weight force of rider $= 522.5$ N

$$\text{Total weight force} = \frac{522.5}{0.55 \text{ N}}$$

$$= 950 \text{ N}$$

$$\text{Mass} = \frac{950}{10 \text{ kg}}$$

$$= 95 \text{ kg}$$

Question 23 (b) (ii)

Criteria	Marks
• Shows relevant working in the correct calculation of the power produced by the rider	2
• Provides some relevant information	1

Sample answer:

$F = 500\text{N}$

$s = 20\ \text{m}$

$t = 5\ \text{secs}$

To find Power produced by the rider:

$$P = Fv = F\frac{s}{t}$$

$$P = 500 \times \frac{20}{5}$$

$$P = 500 \times 4$$

$$P = 2000\ \text{W}$$

Question 23 (c)

Criteria	Marks
• Provides an appropriate explanation of how power is generated by the dynamo	3
• Provides some aspects of how the generator works	2
• Provides some relevant information	1

Sample answer:

As the bicycle wheel rotates, the shaft, connected to the roller, spins the armature through a magnetic field produced by stationary magnets attached to the casing of the generator. This results in the generation of electricity, with the commutator ensuring a DC output. Wires are connected from the dynamo to the light causing the lights to be lit.

Question 24 (a)

Criteria	Marks
• Describes why concrete would have been selected for the pad	3
• Outlines the use of concrete for the pad	2
• Provides some relevant information	1

Sample answer:

Concrete as a whole has a high compressive strength and is a material that can be formed into a wide variety of shapes. Irregular shapes such as the pad shown can be formed with relative ease onsite using appropriate formwork techniques. This provides greater flexibility in the design and construction of civic projects.

Answers could include:

- Concrete can be pre-formed offsite and then transported and assembled at the site of construction.
- It can be strengthened easily by the addition of reinforcing mechanisms.

Question 24 (b)

Criteria	Marks
• Describes steps required for an appropriate method to manufacture the yoke	3
• Outlines some steps to manufacture the yoke	2
• Provides some relevant information	1

Sample answer:

The yoke is stamped out of a piece of steel plate. The holes and the slot are then punched out by a press. The pressed plate is then formed around a mandrel to develop the final shape. Further finishing and polishing follows.

Question 24 (c)

Criteria	Marks
• Shows relevant working in the correct calculation of the axial load	3
• Makes progress towards calculating axial load using a substantially correct method	2
• Provides some relevant information	1

Sample answer:

$\varnothing = 40$ mm

$\sigma = 55$ MPa

$F = ?$N

Note: Keeping σ in MPa and $\varnothing$ in mm allows for the solution F to be given in N.

$$\sigma = \frac{F}{A}$$

$$A\sigma = F$$

$$\pi \times \frac{D^2}{4} \times 55 = F$$

$$\pi \times \frac{40^2}{4} \times 55 = F$$

$$\pi \times \frac{1600}{4} \times 55 = F$$

$$\pi \times 400 \times 55 = F$$

$$\therefore \quad F = 69115.04 \text{ N}$$

The system is in double shear.

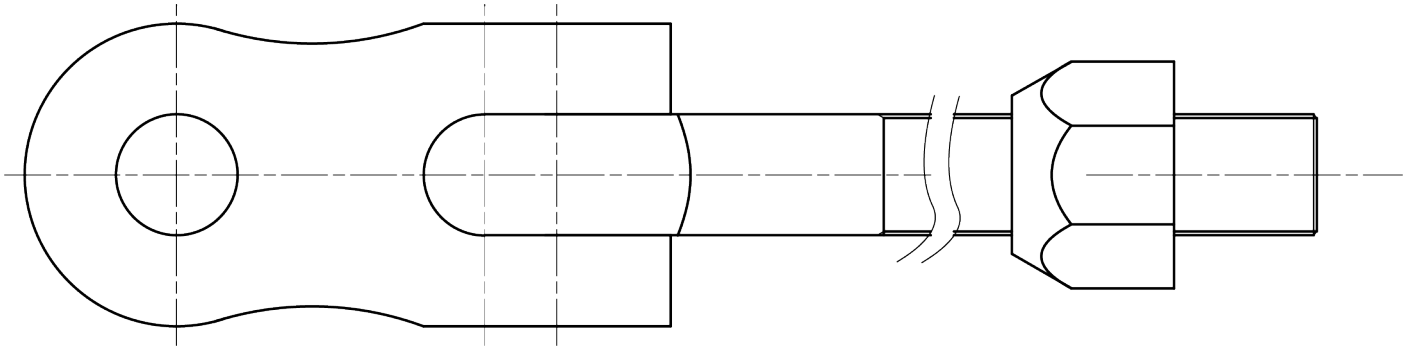
$\therefore F = 138230.08$ N

$F = 138.23$ kN

Question 24 (d)

Criteria	Marks
• Provides a completed correct assembled front view	3
• Provides a substantially correct assembled front view	2
• Provides some aspects of a correct assembled front view	1

Sample answer:



Question 25 (a)

Criteria	Marks
• Describes potential legal and ethical implications of an engineer failing to undertake ongoing training	3
• Outlines a potential legal and/or ethical implication of an engineer failing to undertake ongoing training	2
• Provides some relevant information	1

Sample answer:

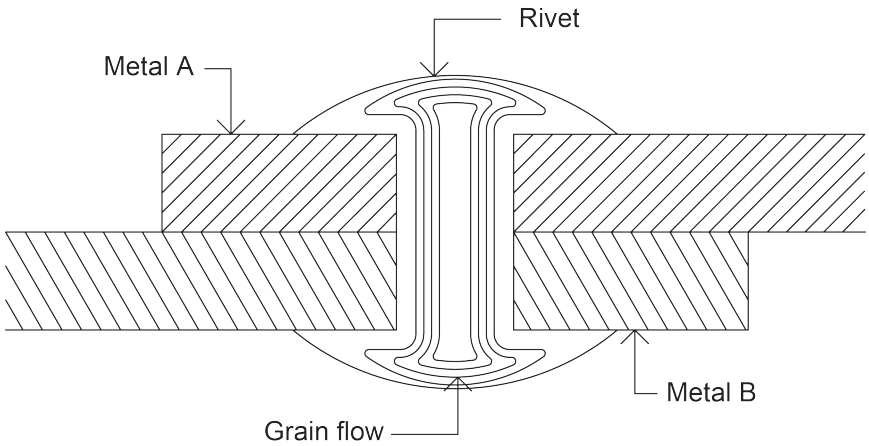
If engineers fail to undertake ongoing training they may not satisfy their legal and/or ethical obligations to maintain up-to-date training in safety, design and engineering best practice. They are exposed to potential legal litigation and may expose themselves and others to potential injury or death, which is an ethical issue.

Question 25 (b)

Criteria	Marks
• Describes the hot working process the rivet has undergone • Supports answer by completing and labelling the sectioned rivet	3
• Describes some aspects of the hot working process the rivet has undergone • May support answer with a relevant sketch	2
• Provides some relevant information	1

Sample answer:

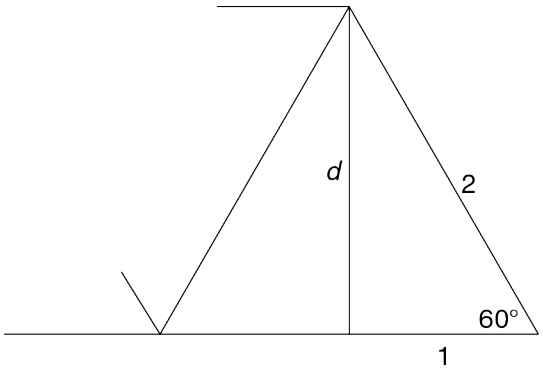
For hot working the rivet has to be heated above the recrystalisation temperature of the material. A riveting gun is then used to hot forge the head of the rivet in place. This results in grain flow forming around the head of the rivet.



Question 25 (c)

Criteria	Marks
• Shows relevant working in the correct calculation of the magnitude of the force • States its nature	6
• Calculates the magnitude of the force using a substantially correct method • States its nature	4–5
• Makes substantial progress towards calculating the reaction at *A*	3
• Makes some progress towards calculating a reaction	2
• Applies an appropriate method	1

Sample answer:



If the length of a member of the truss = 2 then:

$$\sin 60° = \frac{d}{2}$$

$$d = 2\sin 60°$$

$$d = 2 \times 0.8660$$

$$d = 1.732 \text{ units}$$

$$+\circlearrowleft \Sigma M_B = 0 = (3000 \times 1.732) + (20\,000 \times 4) + \left(-R_A \times 6\right) + (1200 \times 8)$$

$$+\circlearrowleft \Sigma M_B = 0 = 5196 + 80\,000 - 6R_A + 9600$$

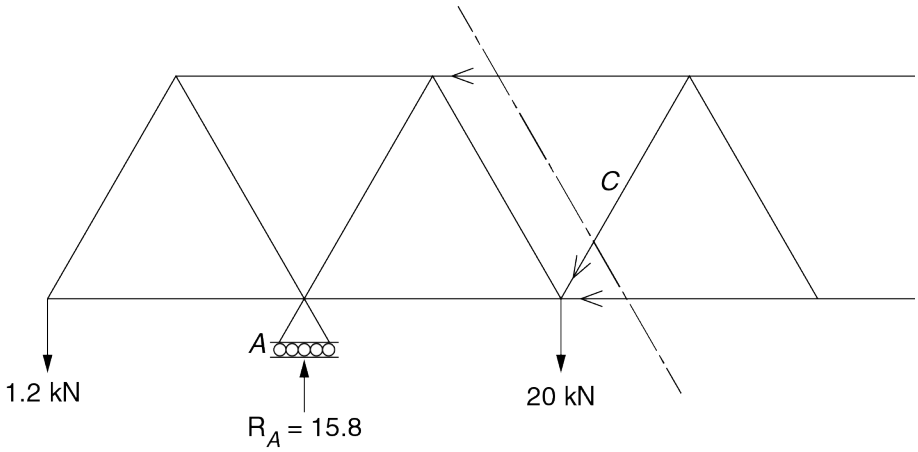
$$+\circlearrowleft \Sigma M_B = 0 = 94796 - 6R_A$$

$$+\circlearrowleft \Sigma M_B = 6R_A = 94796$$

$$+\circlearrowleft \Sigma M_B = R_A = \frac{94796}{6}$$

$$+\circlearrowleft \Sigma M_B = R_A = 15\,799.33$$

$$+\circlearrowleft \Sigma M_B = R_A = 15.80 \text{ kN} \uparrow$$



$$\sin 60° = \frac{y}{C}$$

$$y = C\sin 60°$$

$$+\uparrow \sum F_Y = 0 = -1200 + 15\,799.33 - 20\,000 - \left(C\sin 60°\right)$$

$$+\uparrow \sum F_Y = C\sin 60° = -1200 + 15\,799.33 - 20\,000$$

$$+\uparrow \sum F_Y = C\sin 60° = -5400.667$$

$$+\uparrow \sum F_Y = C\sin 60° = 5401$$

$$+\uparrow \sum F_Y = C = -\frac{5401}{\sin 60°}$$

$$+\uparrow \sum F_Y = C = -\frac{5401}{0.866}$$

$$+\uparrow \sum F_Y = C = -6236.54$$

$\therefore$ Assumed direction is incorrect.

$\therefore$ Reaction in C is away from the joint.

$\therefore$ C = 6.24 kN in tension.

Question 26 (a)

Criteria	Marks
• Describes methods to protect civil structures against corrosion, with appropriate example(s)	3
• Outlines a method(s) to protect civil structures against corrosion	2
• Provides some relevant information	1

Sample answer:

A civil structure, such as railway tracks, can be protected by having a sacrificial anode (eg a block of zinc) connected to the structure so that any corrosion that might occur does so at the sacrificial anode.

Surface coating can be applied eg organic-based paints or salt films to protect the surface of the metallic structure, eg the Sydney Harbour Bridge.

Answers could include:

Galvanic protection
Ceramic coating
Oxide films.

Question 26 (b)

Criteria	Marks
• Outlines benefits of digital signal transmission	3
• Outlines a benefit of digital signal transmission	2
• Provides some relevant information	1

Sample answer:

The benefits of digital signal transmission include: immunity to transmission noise and interference resulting in a clearer signal being received; regeneration of the coded signal along the transmission path which mitigates attenuation of the signal; the use of encryption to keep 'private' communication 'secured'; allows for processing and multiplexing; and allows for the measurement and evaluation of digital signals.

Answers could include:

Possible to:

- use a uniform format for different kinds of baseband signals
- store the signal and process it further.
- evaluate error performance.

Question 26 (c)

Criteria	Marks
• Provides points for and/or against methods for increasing the signal strength of a receiving antenna	3
• Describes a method(s) for increasing the signal strength of a receiving antenna	2
• Provides some relevant information	1

Sample answer:

There are several ways to increase signal strength when receiving a signal, eg amplification and antenna tuning. Amplifiers will amplify sound, including noise that may not be wanted, and may simply result in a louder version of the same noisy signal. The antenna length can be tuned to the frequency of interest. This can be done by adjusting the length of the antenna. However the antenna length required may not be suitable for the location.

Answers could include:

Using a directional antenna that is designed to focus the signal energy can also increase the signal strength. However, incorrect alignment may entirely lose the signal.

Question 26 (d)

Criteria	Marks
• Explains how the speed of a DC traction motor can be controlled, with reference to the diagram	3
• Describes some aspect of how the speed of a DC traction motor can be controlled, with reference to the diagram	2
• Provides some relevant information	1

Sample answer:

By varying the input current using the resistors and switches shown in the diagram, a DC motor can be increased in speed and torque. Starting with a low input current, various resistors can be switched out of the system. The greater number of resistors that are switched out of the system, the greater the current to flow to the motor, thus increasing the vehicle's speed.

Question 27 (a)

Criteria	Marks
• Explains why AS 1100 drawing standards are important	2
• Provides some relevant information	1

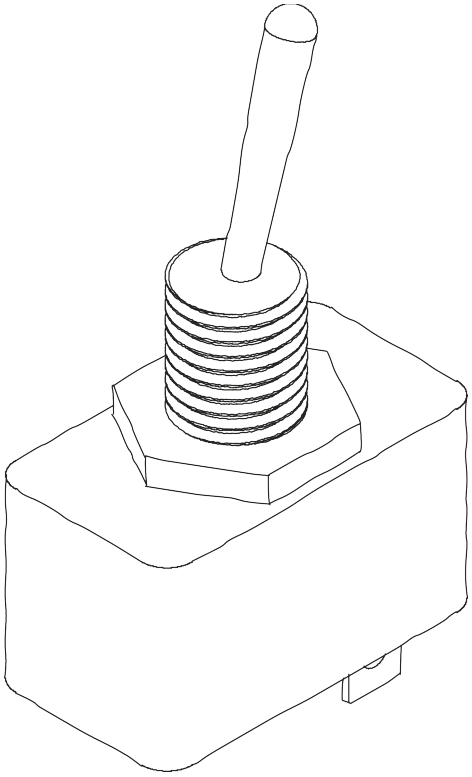
Sample answer:

Provides an unambiguous, standard method of communicating engineering production drawings that can be applied nationally and correctly interpreted internationally.

Question 27 (b)

Criteria	Marks
• Demonstrates extensive knowledge of pictorial drawing, completing a correct projection of the toggle switch at the correct scale	6
• Demonstrates sound knowledge of pictorial drawing, completing a substantially correct projection of the toggle switch	5
• Demonstrates some knowledge of pictorial drawing, with substantial progress towards producing an appropriate pictorial drawing of the toggle switch	3–4
• Makes some progress towards producing a pictorial drawing of the toggle switch	2
• Provides some aspects of a pictorial drawing	1

Sample answer:



2020 HSC Engineering Studies Mapping Grid

Section I

Question	Marks	Content	Syllabus outcomes
1	1	Telecommunications engineering — engineering materials – p37	H1.2
2	1	Aeronautical engineering — communication – p32	H2.2
3	1	Personal and public transport — engineering materials – p29	H2.1
4	1	Civil structures — engineering mechanics – p25	H3.1
5	1	Telecommunications engineering — scope of the profession – p36	H1.1
6	1	Personal and public transport — engineering electricity/electronics – p29	H2.1
7	1	Aeronautical engineering — engineering mechanics and hydraulics – p32	H6.1
8	1	Civil structures — historical and societal influences – p24	H4.2
9	1	Civil structures — engineering materials – p25	H2.1
10	1	Aeronautical engineering — scope of the profession – p31	H1.1
11	1	Personal and public transport — communication – p28 and p33	H3.1
12	1	Telecommunications engineering — engineering electricity/electronics – p37	H2.2
13	1	Telecommunications engineering — engineering materials – p37	H1.2
14	1	Personal and public transport — engineering mechanics – p28	H3.1
15	1	Civil structures — engineering mechanics – p25	H3.1
16	1	Aeronautical engineering — engineering materials – p33	H1.2
17	1	Civil structures — communication – p26	H3.3
18	1	Personal and public transport — engineering materials – p29	H2.1
19	1	Aeronautical engineering — engineering mechanics and hydraulics – p32	H2.2
20	1	Telecommunications engineering — engineering electricity/electronics – p37	H1.2

Section II

Question	Marks	Content	Syllabus outcomes
21 (a)	2	Telecommunications engineering — historical and societal influences – p36	H4.1
21 (b)	3	Telecommunications engineering — engineering electricity/electronics – p37	H3.1
21 (c)	4	Aeronautical engineering — communication – p33	H3.3
21 (d)	3	Telecommunications engineering — engineering materials – p36	H1.2

Question	Marks	Content	Syllabus outcomes
22 (a)	2	Aeronautical engineering — scope of the profession – p31	H1.1
22 (b)	3	Aeronautical engineering — engineering materials – p32–33	H1.2
22 (c)	4	Aeronautical engineering — engineering materials – p32	H1.2
22 (d)	4	Aeronautical engineering — engineering mechanics and hydraulics – p32	H3.1
23 (a)	3	Personal and public transport — historical and societal influences – p27	H4.2
23 (b) (i)	3	Personal and public transport — engineering mechanics – p28	H3.1
23 (b) (ii)	2	Personal and public transport — engineering mechanics – p28	H3.1
23 (c)	3	Personal and public transport — engineering electricity/electronics – p29	H2.1
24 (a)	3	Civil structures — engineering materials – p26	H2.1
24 (b)	3	Personal and public transport — engineering materials – p28	H2.1
24 (c)	3	Civil structures — engineering mechanics – p25	H3.1
24 (d)	3	Civil structures — communication – p26	H3.3
25 (a)	3	Telecommunications engineering — scope of the profession – p36	H1.1
25 (b)	3	Personal and public transport — engineering materials – p28	H1.2
25 (c)	6	Civil structures — engineering mechanics – p25	H3.1
26 (a)	3	Civil structures — engineering materials – p26	H2.1
26 (b)	3	Telecommunications engineering — engineering electricity/electronics – p37	H2.2
26 (c)	3	Telecommunications engineering — engineering electricity/electronics – p37	H2.2
26 (d)	3	Personal and public transport — engineering electricity/electronics – p29	H3.1
27 (a)	2	Aeronautical engineering — communication – p33	H3.3
27 (b)	6	Telecommunications engineering — communication – p37	H3.3